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Quarterly Status Report Number 10  
NEODYMIUM LASER GLASS IMPROVEMENT PROGRAM

(2)

ARPA Order Number 306-20  
Project Code Number 7300  
Contract Number Nonr-3835(00)

Office of Naval Research  
Navy Department  
Washington, D. C.

Author: Dr. Richard F. Woodcock

Project Scientist: Dr. William R. Prindle

V ✓ American Optical Company  
Southbridge, Massachusetts

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During the three-month period ending 30 September 1964 the main area of investigation has been the study of the effects of thermal gradients on the optical path length of glass lasers.

### Thermal Studies

As stated previously a series of glasses containing varying amounts of fifteen of the more commonly used glass ingredients has been designed to study the effect of composition on the thermal coefficient of the refractive index  $\alpha_n$  and the thermal expansion coefficient  $\alpha_L$ . Two of this series devitrified in the melting process. Their compositions have been modified and a second attempt will be made to melt them.

The expansion coefficients have been measured on most of the above glasses. When the remaining glasses have been measured the data will be submitted to a regression analysis on a 1620 IBM computer to look for a correlation between composition and expansion coefficient.

Samples for the measurement of the thermal coefficient of the index of refraction have been prepared from all of the above successful melts. The coefficient has been measured on about half of these to date. This data will also be submitted to regression analysis when measurements on the whole series are complete.

In addition to the above effects, the effect of composition on the shift in index due to stress will also be investigated. Methods of measuring the absolute shift in index with pressure are being studied since the conventional stress-optical coefficient by definition measures only the birefringence introduced by stress, i.e. the difference in the refractive indices of the extraordinary and the ordinary rays.

Theory predicts that different values of  $\alpha_n$  and  $\gamma$  (where  $\gamma = n (\alpha_n + \alpha_L) / \alpha_L$ ) are required to produce zero shift in optical path length of laser rods of configuration extremes, namely, a long single rod and a rod composed of short discs stacked together. To test this theory<sup>1</sup> two series of laser rods have been fabricated all with a total length of 2" - one with a diameter of 3/8", the other 3/4". Each series consists of 5 lasers ranging from a single rod to a stacked array of 16 discs,

<sup>1</sup>This phase of the work being supported in part by contract DA-01-021-AMC-1066a(z)

each 1/8" long. These rods have been set up in an interferometer and pumped with an FT-524 xenon flashtube and a small amount of preliminary data has been obtained to date.

#### Conversion Efficiency

Conversion efficiencies have been measured on 5 rods of a Rb-Ba-silicate laser glass containing 7 wt.% Nd<sub>2</sub>O<sub>3</sub>. Efficiencies above threshold of 4.9, 5.5, 4.8, 4.6 and 4.8% were obtained compared to 3.5% for a K(Na)-Ba-silicate and 2.7% for a Na(K,Li)-Ba-silicate, each containing 5 wt.% Nd<sub>2</sub>O<sub>3</sub>. This result shows a very close correlation between conversion efficiency and neodymium concentration expressed in ions/cc.

#### Supplementary Information

- (A) Technical Summary Report Number 4
- (B) There were no graduate students or past-doctoral personnel associated with this project during the year.
- (C) No graduate students earned their doctorate on this contract.
- (D) The principal investigator for this project, W. R. Prindle, is also associated with Nonr-4656(00) Preparation of Platinum-for Laser Glass.